LUTROS, LLC

Bridgeport Biodiesel Potential to Emit Estimates

Prepared for
BRIDGEPORT BIODIESEL, LLC #1

by
LUTROS, LLC

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Submitted by:

Travis Danner
Vice President Engineering
LUTROS, LLC
721 Scenic Highway
Lookout Mountain, TN 37350
Phone: 423.702.4414
Fax: 423.702.4413
Mobile: 770.655.6736
E-mail: travis@lutros.com
www.lutros.com

EXECUTIVE SUMMARY

The potential to emit estimates presented herein have been prepared for Bridgeport Biodiesel, LLC (BBD) in regards to the biodiesel process installed at 146 Andover St., #1 Bridgeport, CT. The Bridgeport Biodiesel, LLC process has both point sources and fugitive sources of potential emissions. The point sources consist of four storage tanks and a vented batch reaction vessel. The fugitive emissions are associated with production process equipment—the leaks and fugitive emissions from biodiesel and glycerin product load-out to tank trucks. Methanol is the only Hazardous Air Pollutant (EPA-regulated HAP) used in or emitted from the biodiesel process installed as *Bridgeport Biodiesel.* BBD utilizes electric heat and has no fired-boiler/heater thus there are no emissions associated with production of process heat.

The biodiesel production process tank vents and fugitive emissions sources will have the potential to emit methanol, which is both a HAP and a volatile organic compound (VOC) and negligible amounts of non-methanol VOC. Methanol is used as an ingredient both in pure form and as a 70% solution → $\frac{\text{70g methanol}}{\text{100mL soln}}$ with sodium methylate. The table below summarizes the potential to emit methanol from storage, process leaks, and the process exhaust and non-methanol VOC from vegetable oil, biodiesel and glycerin storage and load-out. Potential to emit resulting from feedstock and product storage was calculated according to the procedure presented in AP-42, Section 7.1.3. Calculations of standing and working losses were conducted based on the monthly average temperatures rather than a yearly average. Potential to emit due to fugitive leak emissions was estimated using the Average Emission Factor Approach as outlined in Section 2.3.1 of the 1995 Protocol for Equipment Leak Emission Estimates (EPA-453/R-95-017, 1995). The SOCMI average emission factors provided in the procedure are likely over-estimates as the process conditions (temperature and pressure) for the biodiesel process are low; additionally, those pipes containing pure methanol and methylate are small (1" or smaller). Fugitive potential to emit estimates for a biodiesel process based on SOCMI average emissions factors are likely overestimates, if not gross overestimates. As a comparison, potential to emit due to fugitive emissions was also estimated using the EPA Correlation Approach based on screening values presented in the Technical Support Document for Air Emissions Permit No. 04700061-002 pertaining to a permit for a 30 MM gal/yr biodiesel plant by the Renewable Energy Group, Inc. in Albert Lea, Minnesota. Potential VOC emissions due to load-out of biodiesel and glycerin product were calculated using the procedures in AP-42, Section 5.2.

The combined total potential to emit methanol from all sources based on SOCMI factors is estimated at **7.16 tons/yr** based on SOCMI average factors and **6.38 tons/yr** based on REG screening values. Note that fugitive emissions based on SOCMI factors are four times higher than those calculated by available screening data for biodiesel plants. The total potential to emit methanol in either case is less than 10 tons/yr and the combined total potential to emit all HAPs is less than 25 tons/yr. Total VOC potential emissions, including negligible emissions from non-methanol tank storage and product load-out operations and total potential emissions of all other regulated pollutants, will also be less than 10 TPY. On the basis of total criteria pollutant and HAP emissions from all sources, *Bridgeport Biodiesel* would be classified as a minor source of criteria pollutants and HAPs and would emit less than 15 TPY of any regulated pollutant. Consequently, Bridgeport Biodiesel would not need a CTDEEP air permit to operate.

Methanol/VOC Potential Emissions Summary:

	SOCMI Correl	SOCMI Ave
	tons/yr	tons/yr
Tank Storage	0.26	0.26
Fugitive Emissions	0.15	0.93
Other Process Emissions	5.97	5.97
Total Potential to Emit Methanol	**6.38**	**7.16**

Non-Methanol VOC Potential Emissions

	tons/yr
VOC from Vegetable Oil Feedstock Storage and Biodiesel and Load-out	<0.01

Bridgeport Biodiesel Total Premise Potential Emissions Summary:

	SOCMI Correl	SOCMI Ave
	tons/yr	Tons/yr
Methanol (HAP)	6.38	7.16
Total HAPs	6.39	7.17

The following potential to emit estimates are prepared for the biodiesel plant installed as *Bridgeport Biodiesel* at 146 Andover St, Bridgeport, CT. At this location Bridgeport Biodiesel, LLC will use only one substance classified by the EPA as a Hazardous Air Pollutant (HAP) in its everyday manufacturing operations: methanol. BBD's methanol usage is the only sources of potential emissions of HAPs and criterion pollutants for *Bridgeport Biodiesel*; emissions estimates from each potential source of methanol are presented below.

Methanol Emissions:

BBD's installed production hardware has a theoretical annual capacity of 1,545,750 MM gal/yr of finished biodiesel. This maximum capacity is calculated based on the maximum batch size (490 gallons) of the installed transesterification reactor combined with its minimum turn over time of 2.76 hrs. (This will require a net methanol usage of less than 390,000 gal/yr, and a sodium methylate usage of 63,500 gal/yr which will be purchased as a 70% methanol solution. There are three primary sources of methanol emissions: material storage, fugitive emissions, and process related sources. Each of these sources will be addressed in turn.

Storage Emissions:

Potential to emit from material storage was estimated for each material having some component of methanol in it. These materials include pure methanol, sodium methylate (70% methanol), byproduct glycerin (20% methanol), and byproduct wash water (2% methanol). The potential to emit was estimated using the procedure presented in AP-42, Section 7.1.3: Calculations of standing and working losses were conducted based on the monthly average temperatures of New York, NY (the closest city to Bridgeport, CT for which data was provided in AP-42, Table 7.1-7) as opposed to an annual average. Note that all storage tanks are indoors without climate control and as such solar insolation was assumed to be 0, however, the daily temperature variation was determined as though the tanks were outdoors. Tank characteristics and expected annual turnover are provided in Table 1. Various constants used for the calculations are provided in Table 2. Tabular data of the calculations are provided in Appendix A. Table 3 shows the results from these calculations. **Note that the potential to emit due to standing and working losses of the four storage tanks containing at least some component methanol is 0.26 tons/yr.**

Tank No.	Content	Dia [ft]	Ht [ft]	Capacity [Gal]	Annual Throughput [Gal]	Annual Turnovers
1	Biodiesel	8	16	6,000	463,725	86
2	Biodiesel	8	16	6,000	463,725 SUM 1,545,750 gal	86
3	Biodiesel	8	16	6,000	463,725	86
4	Bio Rework	8	16	6,000	154,575	29
5	Yellow Grease	8	16	6,000	412,200	76
6	Yellow Grease	8	16	6,000	412,200 SUM	76
7	UCO	8	16	6,000	412,200	76
8	UCO	8	12	4,500	309,150	76
9	Methanol (100% MeOH)	8	21	8,000	386,438	54
10	Sodium Methylate (70% MeOH)	8	16	6,000	63,350	12
11	Wash Water (2% MeOH)	8	16	6,000	168,461	31
12	Crude Glycerin (20% MeOH)	8	16	6,000	289,253	54
13	Bio-Water	8	16	6,000	289,253	54

Table 1: Storage tank capacities, contents, and turnovers

	Methanol	30% Methylate Solution	
Molecular Weight	32.04	38.628	lb/lb-mol
Paint Factor (α)	0.255	0.255	white tanks
Vap. Press Const. A	7.897	8.613	
Vap. Press Const. B	1474.08	2199.60	[C]
Vap. Press Const. C	229.13	285.21	[C]
Universal Gas Constant	10.731	10.731	psia-ft3 / lb_mol-R
Tank Vent Pressure	+/- 0.03	+/- 0.03	psig
Atmospheric Pressure	14.696	14.696	psia

Table 2: Storage tank and constituent constants

Tank No.	Content	Standing Losses [tons/yr]	Working Losses [tons/yr]	Total Losses [tons/yr]
9	Methanol	0.03	0.15	0.17
10	Sodium Methylate	0.01	0.02	0.04
11	Wash Water	0.02	0.00	0.03
12	Crude Glycerin	0.01	0.01	0.02
	Total potential to emit due to storage			0.26

Table 3: Storage related potential to emit estimates

Fugitive Emissions:
Potential to emit due to fugitive emissions was estimated using the Average Emission Factor Approach as outlined in Section 2.3.1 of the 1995 Protocol for Equipment Leak Emission Estimates. Note, however, that the source categories for which emissions factors are available do not likely accurately represent a biodiesel process. Note the following excerpt from the protocol:

> For process units in source categories for which emission factors and/or correlations have not been developed, the factors and/or correlations already developed can be utilized. However, appropriate evidence should indicate that the existing emission factors and correlations are applicable to the source category in question. Criteria for determining the appropriateness of applying existing emission factors and correlations to another source category may include one or more of the following: (1) process design, (2) process operation parameters (i.e., pressure and temperature), (3) types of equipment used, and (4) types of material handled. For example, in most cases, SOCMI emission factors and correlations are applicable for estimating equipment leak emissions from the polymer and resin manufacturing industry. This is because, in general, these two industries have comparable process design and comparable process operation, they use the same types of equipment, and they tend to use similar feedstock. (Page 2-5,2-6)

Biodiesel processes do not employ the same feedstocks as polymer and resin manufacturing; they do not employ similar processes. While biodiesel processes may employ similar equipment to polymer and resin manufacturing, they do not likely employ similar pressures and temperatures. Most equipment components in a biodiesel process are not exposed to methanol concentrations over 20%, i.e. most of the fluid mixtures throughout the reaction process are defined as heavy liquids. Most of the fugitive emissions are, however, contributed by the streams of pure methanol delivered to the reaction process. Most all components in the delivery streams are at ambient temperature, at only slightly elevated pressures (< 20 psi). Consequently, actual emissions for these streams are expected to be significantly lower than those predicted from the provided SOCMI average emissions factors for dissimilar processes comprised of larger equipment, higher temperatures, and higher pressures. **Fugitive potential to emit estimates for a biodiesel process based on SOCMI average emissions factors are likely to be overestimates, if not gross overestimates.** The SOCMI factors have been used with the understanding that the resulting estimates are unrepresentatively high.

In addition to these SOCMI emission factors, fugitive potential to emit estimates have also been calculated based on the EPA Correlation Approach using screening values presented in the Technical Support Document for Air Emissions Permit No. 04700061-002 submitted for a 30 MM gal/yr biodiesel plant by the Renewable Energy Group, Inc. in Albert Lea, MN —"The facility measured concentrations around 50 ppmv from the equipment leaks and applied a factor of safety of 4 to arrive at [a screening value of] 200 ppmv." This screening value of 200 ppm was used in the EPA Correlation Approach to establish representative leak rates.

The SOCMI average emission factors are provided in Table 5a; this table corresponds to Table 2-1 of the 1995 Protocol for Equipment Leak Emission Estimates. Table 5b displays the SOCMI leak rate/screening correlations; this table corresponds to Table 2-9 of the 1995 Protocol for Equipment Leak Emission Estimates. Table 6 provides the component types and quantities within the biodiesel process that service a mixture having some fraction of either methanol or sodium methylate. Also provided in Table 6 are the process subsystems and their corresponding potential to emit due to fugitive emissions. **Note the total potential to emit resulting from fugitive emissions is estimated at 0.93 tons/yr using the SOCMI average emission factors which are expected to be overly conservative given the process design and operational parameters of the biodiesel system.** Total potential to emit resulting from fugitive emissions is 0.16 tons/yr using the SOCMI screening/leak rate correlations which are expected to be more realistic estimates for a biodiesel plant. Note that a safety factor of 35 would have to be applied to actual concentration measurements before estimates from the correlation approach would exceed that of the average factor approach. Tabular data for the fugitive emissions calculations are provided as Appendix B.

Equipment type	Service	Emission factor[a] (kg/hr/source)
Valves	Gas	0.00597
	Light liquid	0.00403
	Heavy liquid	0.00023
Pump seals[b]	Light liquid	0.0199
	Heavy liquid	0.00862
Compressor seals	Gas	0.228
Pressure relief valves	Gas	0.104
Connectors	All	0.00183
Open-ended lines	All	0.0017
Sampling connections	All	0.0150

Table 5a: SOCMI average emission factors

Equipment type	Correlation[a,b]
Gas valves	Leak rate (kg/hr) = 1.87E-06 x $(SV)^{0.873}$
Light liquid valves	Leak rate (kg/hr) = 6.41E-06 x $(SV)^{0.797}$
Light liquid pumps[c]	Leak rate (kg/hr) = 1.90E-05 x $(SV)^{0.824}$
Connectors	Leak rate (kg/hr) = 3.05E-06 x $(SV)^{0.885}$

Table 5b: SOCMI Leak Rate/Screening Value Correlation

Component Type	Qty	Subsystem	SOCMI Ave [tons/yr]	SOCMI Correl [tons/yr]
Valves	50	Methanol and Methylate Supply	0.42	0.06
Pump Seals	7	Transesterification Reactor	0.49	0.09
Connectors	365	Biodiesel Wash System	0.01	0.01
		Total potential to emit due to fugitive emissions	**0.93**	**0.15**

Table 6: Potential to emit resulting from fugitive emissions

Process Emissions:
BBD's process employees a batch style biodiesel production process. As such there are emissions associated with filling and empting process tanks. These process tanks include the transesterification reactor and three wash tanks. These sources will each be considered in turn.

Transesterification Reactor
The transesterification reactor employed by BBD is a 634 gallon reactor which is filled with 628 gallons of reactants per batch. With a 2.76 hour cycle time, there is the potential for 3,176 batches per year which results in the potential to vent 10.1 tons of air per year. The vapor pressure and corresponding partial pressure of methanol at the average vent conditions (70F, 0 psig) was calculated

to estimate the methanol entrained in these 10.1 tons of air; **the potential to emit methanol due to reactor cycling is 1.74 tons/yr**.

Wash Process Tanks
From the transesterification reactor, reactants are cooled and pumped to one of three 6,000 gal wash tanks wherein byproduct glycerin is settled and contaminates including methanol are water-washed from the biodiesel. Eight reactor batches enter one wash tank before it is locked out and reactor batches are diverted to one of the other two wash tanks. With eight reactor batches per wash batch there is the potential for 397 wash batches per year distributed among the three wash tanks each containing 5,040 gallons of reacted products. This results in the potential to emit a combined 10.1 tons of air as these tanks are filled. The vapor pressure and corresponding partial pressure of methanol at the average vent conditions (95F, 0 psig) was calculated to estimate the methanol entrained in these 10.1 tons of air; **the potential to emit methanol due to wash tank cycling is 4.24 tons/yr.**

Note that the reactor and wash tanks are vented through a control device—a chilled condenser followed by a scrubber. The condenser is maintained at 60F and alone reduces the combined emissions from the process tanks from a potential of 5.97 tons/yr to a potential of 2.08 tons/yr.

Non-Methanol VOC Emissions
In addition to methanol and sodium methylate *Bridgeport Biodiesel* will use vegetable oil as a feedstock and it will produce biodiesel. Tank storage standing and working losses for these materials were calculated using the same procedures used for the methanol and sodium methylate storage tanks (AP-42, Section 7.1.3). Potential VOC emissions due to load-out of biodiesel product were calculated using the procedures in AP-42, Section 5.2. Potential to emit VOC from the storage and load-out of these fluids was found to be negligible (< 0.01 tons/yr). This is due to the low vapor pressures (< 2 Pa at 100F) of these substances. See assumptions and methodology used to estimate potential VOC emissions in Appendix D.

Summary
Bridgeport Biodiesel will have both point sources and fugitive sources of potential emissions. The point sources consist of four material storage tanks having at least some methanol component and four process tanks (one reactor and three wash tanks) with the potential to emit methanol. Fugitive sources of potential emissions associated with the biodiesel production process consist of fugitive emissions from equipment leaks and fugitive emissions from product load-out to tank trucks.

The biodiesel production process and fugitive emissions sources will have the potential to emit methanol, which is both a federal HAP and a VOC, and negligible amounts of non-methanol VOC. Methanol is used as an ingredient both in pure form and as a 70% solution with sodium methylate. Table 8 summarizes the estimated Potential to Emit methanol from storage, process leaks, and process exhaust. The combined total potential to emit methanol from all sources totals **7.16 tons/yr** based on the average emission factor approach using SOCMI average factors for equipment leaks. The total potential to emit methanol is less than 10 tons/yr and the combined total potential to emit all HAPs is less than 25 tons/yr; on this basis *Bridgeport Biodiesel* is a minor source of HAP. Total VOC potential emissions, including negligible emissions from non-methanol tank storage and product load-out operations, is less than 10 TPY. Therefore, Bridgeport Biodiesel does not need a CTDEEP Air Permit to Operate.

Also note Bridgeport Biodiesel has a CT state permit limiting its production to no more than 1 MM gal/yr. While this does not pose a physical limitation to the production capability of BBD, it does place a real cap on production. At a production rate of 1 MM gal/yr total potential to emit methanol from BBD would decrease from 7.17 tons/yr to 5.04 tons/yr.

	SOCMI Ave	SOCMI Correlation
Tank Storage	**tons/yr**	**tons/yr**
Methanol	0.03	0.15
Sodium Methylate	0.01	0.02
Wash Water	0.02	0.00
Crude Glycerin	0.01	0.01
Subtotal	**0.26**	**0.26**
Fugitive		
Methanol and Methylate Supply	0.42	0.06
Transesterification Reactor	0.49	0.09
Biodiesel Wash System	0.01	0.01
Subtotal	**0.93**	**0.15**
Other Process Sources		
Reactor Vent	1.74	1.74
Wash Tanks Vent	4.24	4.24
Subtotal	**5.97**	**5.97**
Total Potential to Emit Methanol	**7.16**	**6.38**
Total Non-Methanol VOC	**<0.01**	**<0.01**
Total VOC	**7.17**	**6.39**

Table 8: Total Methanol and VOC Potential to Emit

Appendix A: Intermediate parameter calculations for standing and working losses relating to storage.

Table 9		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ave
New York	T_AX [F]	37.4	39.2	47.3	59.6	69.7	78.7	83.9	82.3	75.2	64.5	52.9	41.5	61.0
NY	T_AN [F]	26.1	27.3	34.6	44.2	53.7	63.2	68.9	68.2	61.2	50.5	41.2	30.8	47.5
	I [btu/ft2-d]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T_AA [F]	31.8	33.3	41.0	51.9	61.7	71.0	76.4	75.3	68.2	57.5	47.1	36.2	54.3
	T_B [F]	32.3	33.8	41.5	52.4	62.2	71.5	76.9	75.8	68.7	58.0	47.6	36.7	54.8
	T_LA [F]	32.0	33.5	41.2	52.2	62.0	71.2	76.7	75.5	68.5	57.8	47.3	36.4	54.5
Methanol	P_VA [psia]	0.6	0.6	0.8	1.1	1.5	2.0	2.4	2.3	1.9	1.3	1.0	0.7	1.2
Methylate	P_VA [psia]	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.5	0.4	0.3	0.2	0.3
Wash Water	P_VA [psia]	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Crude Gly	P_VA [psia]	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
	Wv [lb/ft3]	0.0034	0.0036	0.0046	0.0065	0.0088	0.0114	0.0133	0.0129	0.0106	0.0078	0.0056	0.0040	0.0070
	dT_A [R]	11.3	11.9	12.7	15.4	16.0	15.5	15.0	14.1	14.0	14.0	11.7	10.7	13.5
	dT_V [R]	8.1	8.6	9.1	11.1	11.5	11.2	10.8	10.2	10.1	10.1	8.4	7.7	9.7
	T_LX [F]	37.7	39.5	47.6	59.9	70.0	79.0	84.2	82.6	75.5	64.8	53.2	41.8	61.3
	T_LN [F]	26.4	27.6	34.9	44.5	54.0	63.5	69.2	68.5	61.5	50.8	41.5	31.1	47.8
	T_BX [F]	37.9	39.7	47.8	60.1	70.2	79.2	84.4	82.8	75.7	65.0	53.4	42.0	61.5
	T_BN [F]	26.6	27.8	35.1	44.7	54.2	63.7	69.4	68.7	61.7	51.0	41.7	31.3	48.0
Methanol	P_VX [psia]	0.7	0.7	1.0	1.4	2.0	2.6	3.0	2.9	2.3	1.7	1.2	0.8	1.5
Methanol	P_VN [psia]	0.5	0.5	0.6	0.9	1.2	1.6	1.9	1.9	1.5	1.1	0.8	0.5	1.0
Methanol	dP_V [psia]	0.2	0.3	0.3	0.6	0.8	1.0	1.1	1.0	0.8	0.6	0.4	0.3	0.5
Methylate	P_VX [psia]	0.2	0.2	0.3	0.4	0.5	0.7	0.8	0.8	0.6	0.5	0.3	0.2	0.4
Methylate	P_VN [psia]	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.4	0.3	0.2	0.2	0.3
Methylate	dP_V [psia]	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1
Wash Water	P_VX [psia]	0.4	0.4	0.5	0.8	1.0	1.3	1.6	1.5	1.2	0.9	0.6	0.4	0.8
Wash Water	P_VN [psia]	0.2	0.3	0.3	0.5	0.6	0.8	1.0	1.0	0.8	0.6	0.4	0.3	0.5
Wash Water	dP_V [psia]	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.5	0.4	0.3	0.2	0.1	0.3
Crude Gly	P_VX [psia]	0.1	0.1	0.2	0.3	0.3	0.5	0.5	0.5	0.4	0.3	0.2	0.1	0.3
Crude Gly	P_VN [psia]	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.1	0.1	0.2
Crude Gly	dP_V [psia]	0.04	0.04	0.06	0.10	0.14	0.17	0.19	0.17	0.14	0.11	0.07	0.04	0.09

Methanol	K_E	0.04	0.04	0.05	0.08	0.10	0.12	0.13	0.11	0.09	0.07	0.05	0.04	0.07
Methylate	K_E	0.03	0.03	0.04	0.05	0.07	0.07	0.08	0.08	0.06	0.05	0.04	0.03	0.05
Wash Water	K_E	0.03	0.04	0.05	0.06	0.08	0.08	0.09	0.08	0.07	0.05	0.04	0.03	0.05
Crude Gly	K_E	0.02	0.03	0.03	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.03	0.02	0.04
9	K_s	0.7	0.7	0.7	0.6	0.5	0.4	0.4	0.4	0.5	0.6	0.6	0.7	0.6
10	K_s	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9
11	K_s	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.7	0.8	0.8	0.9	0.8
12	K_s	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0

Appendix A: Intermediate parameter calculations for standing and working losses relating to methanol storage.

Table 10

Tank No.	Description	Volume [gal]	Diameter [ft]	Height [ft]	Hvo [ft]	Vv [ft3]	Q [bbl/yr]	Turnovers /yr	K_N	K_P	d_B [psig]	KB
9	Methanol Storage	8,000	8	21.3	10.6	535	9,197	54	0.73	1	-	1.0
10	Methylate Storage	6,000	8	16	8	402	1,508	12	2.72	1	-	1.0
11	Wash Water	6,000	8	16	8	402	4,009	31	1.00	1	-	1.0
12	Crude Glycerin	6,000	8	16	8	402	6,884	54	0.73	1	-	1.0

Table 11

Tank No.	Standing Losses	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ave	Mon. Tot
9	L_S [lbs]	1.2	1.4	2.1	3.9	6.0	8.1	9.5	8.6	6.6	4.4	2.4	1.4	3.7	56
10	L_S [lbs]	0.7	0.7	1.1	2.0	3.0	4.0	4.7	4.2	3.3	2.2	1.2	0.7	1.9	28
11	L_S [lbs]	0.9	1.0	1.5	3.0	4.9	7.1	8.6	7.7	5.6	3.5	1.8	1.0	2.9	47
12	L_S [lbs]	0.6	0.7	1.0	1.9	2.8	3.8	4.4	4.0	3.1	2.1	1.2	0.7	1.8	26

Table 12

Tank No.	Working Losses	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ave	Mon. Tot
9	L_W [lbs]	10.2	10.8	14.1	20.4	27.9	37.0	43.5	42.0	34.1	24.4	17.4	12.0	22.0	294
10	L_W [lbs]	1.7	1.8	2.4	3.4	4.6	6.1	7.1	6.9	5.6	4.0	2.9	2.0	3.6	48
11	L_W [lbs]	0.2	0.2	0.3	0.4	0.6	0.8	0.9	0.9	0.7	0.5	0.4	0.3	0.5	6
12	L_W [lbs]	0.6	0.6	0.8	1.2	1.7	2.2	2.6	2.5	2.0	1.5	1.0	0.7	1.3	18

Appendix B: Fugitive emissions component list and intermediate calculations.

	Type	Qty	MeOH Mass Fraction	Service per Year	Fluid Class	SOCMI Emit Factor	Screen Emit Factor	Screen Potential to Emit	SOCMI Potential to Emit	Stream Description
			[%]	[hrs/yr]		[kg/hr/ source]	[kg/hr/ source]	[tons/yr]	[tons/yr]	
5	Connections	173	100.0%	618	Light Liquid	0.00183	0.000331674	0.0391	0.2158	Methanol Feed
6	Valve	34	100.0%	618	Light Liquid	0.00403	0.000437299	0.0101	0.0934	Methanol Feed
11	Pump	2	100.0%	1,402	Light Liquid	0.0199	0.001495555	0.0046	0.0615	Methanol Feed
2	Connections	68	70.0%	412	Light Liquid	0.00183	0.000331674	0.0072	0.0396	Methylate Feed
3	Valve	12	70.0%	412	Light Liquid	0.00403	0.000437299	0.0017	0.0154	Methylate Feed
4	Pump	1	70.0%	412	Light Liquid	0.0199	0.001495555	0.0005	0.0063	Methylate Feed
8	Connections	124	19.5%	8,760	Heavy Liquid	0.00183	0.000331674	0.0774	0.4273	Reaction Mixture
9	Valve	4	19.5%	8,760	Heavy Liquid	0.0023	0.000437299	0.0033	0.0173	Reaction Mixture
10	Pump	3	19.5%	8,760	Heavy Liquid	0.00862	0.001495555	0.0084	0.0487	Reaction Mixture
1	Pump	1	20.0%	2,628	Heavy Liquid	0.00862	0.001495555	0.0009	0.0050	Wash Mixture
						Totals		**0.1532**	**0.9303**	

Appendix D: Non-Methanol VOC Emissions, Biodiesel Storage

Table 13

Tank No.	Description	Volume [gal]	Diameter [ft]	Height [ft]	Hvo [ft]	Vv [ft3]	Q [bbl/yr]	Turnovers /yr	K_N	K_P	d_B [psig]	KB
1	Biodiesel Storage	6,000	8	16	8	402	9,389	73	0.58	1	10	1.0
2	Biodiesel Storage	6,000	8	16	8	402	9,389	73	0.58	1	10	1.0
3	Biodiesel Storage	6,000	8	16	8	402	9,389	73	0.58	1	10	1.0
4	Biodiesel Storage	6,000	8	16	8	402	3,130	24	1.40	1	10	1.0

Table 14

Tank No.	Standing Losses	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ave	Mon. Tot
1	L_S [lbs]	0.000	0.000	0.000	0.007	0.001	0.002	0.002	0.002	0.001	0.000	0.000	0.000	0.005	0.02
2	L_S [lbs]	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.002	0.001	0.000	0.000	0.000	0.005	0.01
3	L_S [lbs]	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.002	0.001	0.000	0.000	0.000	0.005	0.01
4	L_S [lbs]	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.002	0.001	0.000	0.000	0.000	0.005	0.01

Table 15

Tank No.	Working Losses	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ave	Mon. Tot
1	L_W [lbs]	0.000	0.000	0.001	0.002	0.005	0.008	0.012	0.011	0.007	0.003	0.001	0.001	0.031	0.1
2	L_W [lbs]	0.000	0.000	0.001	0.002	0.005	0.008	0.012	0.011	0.007	0.003	0.001	0.001	0.031	0.1
3	L_W [lbs]	0.000	0.000	0.001	0.002	0.005	0.008	0.012	0.011	0.007	0.003	0.001	0.001	0.031	0.1
4	L_W [lbs]	0.000	0.000	0.001	0.002	0.004	0.007	0.010	0.009	0.005	0.003	0.001	0.001	0.025	0.0

Appendix D: Non-Methanol VOC Emissions, Biodiesel Storage

Table 16		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ave
New York	T_AX [F]	37.4	39.2	47.3	59.6	69.7	78.7	83.9	82.3	75.2	64.5	52.9	41.5	61.0
NY	T_AN [F]	26.1	27.3	34.6	44.2	53.7	63.2	68.9	68.2	61.2	50.5	41.2	30.8	47.5
	I [btu/ft2-d]	548.0	795.0	1118.0	1457.0	1690.0	1802.0	1784.0	1583.0	1280.0	951.0	593.0	457.0	1171.0
	T_AA [F]	31.8	33.3	41.0	51.9	61.7	71.0	76.4	75.3	68.2	57.5	47.1	36.2	54.3
	T_B [F]	32.3	33.8	41.5	52.4	62.2	71.5	76.9	75.8	68.7	58.0	47.6	36.7	54.8
	T_LA [F]	33.2	35.1	43.5	55.1	65.4	74.9	80.3	78.7	71.1	59.7	48.5	37.4	56.9
	P_VA* [psia]	0.000003	0.000004	0.000007	0.000016	0.000033	0.000060	0.000084	0.000076	0.000047	0.000022	0.000010	0.000004	0.000018
	Wv [lb/ft3]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	dT_A [R]	11.3	11.9	12.7	15.4	16.0	15.5	15.0	14.1	14.0	14.0	11.7	10.7	13.5
	dT_V [R]	12.0	14.2	17.1	21.5	23.6	24.0	23.5	21.5	19.2	16.9	12.7	11.0	18.1
	T_LX [F]	38.8	41.1	49.8	62.8	73.4	82.6	87.8	85.8	78.1	66.7	54.4	42.7	63.7
	T_LN [F]	27.5	29.2	37.1	47.4	57.4	67.1	72.8	71.7	64.1	52.7	42.7	32.0	50.2
	T_BX [F]	37.9	39.7	47.8	60.1	70.2	79.2	84.4	82.8	75.7	65.0	53.4	42.0	61.5
	T_BN [F]	26.6	27.8	35.1	44.7	54.2	63.7	69.4	68.7	61.7	51.0	41.7	31.3	48.0
	P_VX [psia]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	P_VN [psia]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	dP_V [psia]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	K_E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	K_s	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

*The vapor pressure was calculated assuming the biodiesel to be comprised of 100% methyl laurate. Methyl laurate has a molecular weight of 214 lb/mol with vapor pressure constants A, B, and C as follows 9.43, 1958.77K, and -96.99K. Methyl laurate was used for this estimate as it has a higher vapor pressure than any constituent compressing the oil and thus serves as a worst case estimate. Oil has a dramatically lower vapor pressure than methyl laurate and as such potential to emit oil is significantly lower than these estimates for biodiesel.

Appendix D: Non-Methanol VOC Emissions, Biodiesel and Glycerin Load-out

Biodiesel		
Loading Temp	100	F
Molecular Weight	214	lb/lb-mol
Vapor Pressure*	0.00026	psia
S Factor	1.45	Splash Loading
Loading Losses	0.00181	lb/1000 gal
Loadout Volume	13,140,000	gal/yr
Potential to Emit	**0.01192**	**tons/yr**

	Methyl Laurate	
Molecular Weight	214	lb/lb-mol
Paint Factor (alpha)	0.255	
Vap. Press Const. A	9.430	
Vap. Press Const. B	1958.77	[K]
Vap. Press Const. C	-96.99	[K]
Universal Gas Constant	10.731	psia-ft3 / lb_mol-R
Tank Vent Pressure	+/- 0.03	psig
Atmospheric Pressure	14.696	psia

Glycerin		
Loading Temp	100	F
Molecular Weight	92	lb/lb-mol
Vapor Pressure	0.0000040	psia
S Factor	1.45	Splash Loading
Loading Losses	0.00001	lb/1000 gal
Loadout Volume	1,065,329	gal/yr
Potential to Emit	**0.00001**	**tons/yr**

	Glycerin	
Molecular Weight	92	lb/lb-mol
Paint Factor (alpha)	0.255	
Vap. Press Const. A	9.830	
Vap. Press Const. B	2094.65	[K]
Vap. Press Const. C	-126.63	[K]
Universal Gas Constant	10.731	psia-ft3 / lb_mol-R
Tank Vent Pressure	+/- 0.03	psig
Atmospheric Pressure	14.696	psia

Total **0.0119218** **tons/yr**

*The vapor pressure was calculated assuming the biodiesel to be comprised of 100% methyl laurate. Methyl laurate was used for this estimate as it has a higher vapor pressure than any constituent compressing the biodiesel and thus serves as a worst case estimate.